Relate bp to bonding

1) Use the information in the table to answer the following question.

Molecule	Boiling point °C	Molar mass/g mol^{-1}
Water, H_2O	100	18.0
Oxygen, O_2	–183	32.0
Hydrogen sulfide, H_2S	–62	34

Compare and contrast the boiling points of water, oxygen, and hydrogen sulfide in terms of the similarities and differences in the relative strengths of the attractive forces present between particles.

2) Chloroethanol ($HOCH_2CH_2Cl$) and chloropropane ($CH_3CH_2CH_2Cl$) have similar molar masses, but significantly different boiling points.
Identify the substance with the higher boiling point, and justify your choice.

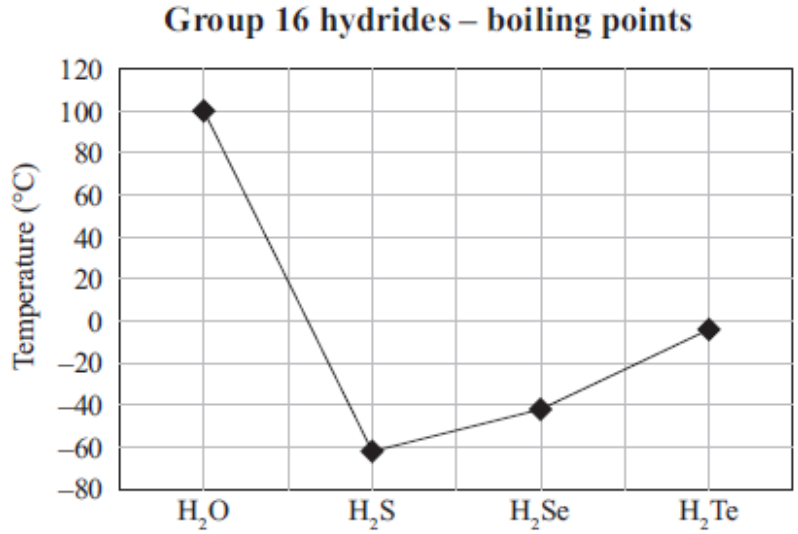
3) Discuss the trend in boiling points shown in the graph below for the Group 16 hydrides.

In your discussion:

• explain why H_2O has a much higher boiling point than the other hydrides

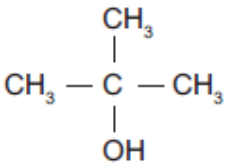
• account for the rise in boiling points from H_2S to H_2Te

• compare the boiling points of H_2S, H_2Se and H_2Te, and explain the observed trend in terms of bonding AND mass.



4) a) Ethanol (CH_3CH_2OH) and propane ($CH_3CH_2CH_3$) have similar molar masses but ethanol is a liquid at room temperature, while propane is a gas. Identify the types of intermolecular forces for each of these substances and explain why ethanol has a higher boiling point than propane.

b) Account for the difference in the boiling points of the two substances in the table below by comparing **all the intermolecular forces**.

Name	Structure	Boiling Point / °C
butan-1-ol	$CH_3CH_2CH_2CH_2OH$	117.7
2-methylpropan-2-ol		82.6

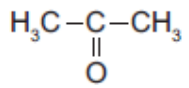
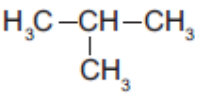
5) Justify the similarity in the $\Delta vap H°$ of CH_3Cl and CH_3NH_2.

	$\Delta_{vap}H°$ (kJ mol^{-1})	Molar mass (g mol^{-1})
CH_3Cl	22	50.5
CH_3NH_2	24	31.0

6) i) Account for the difference in the boiling points for the following pairs of compounds by comparing the main forces between the molecules in each case.

	Boiling point / °C	Molar mass / g mol^{-1}
Compound A, CH_3OH	65	32.0
Compound B, CH_3SH	6	48.1

ii)

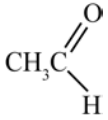
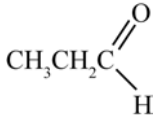
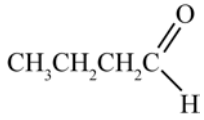
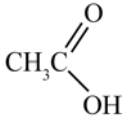
	Boiling point / °C	Molar mass / g mol^{-1}
Compound C, 	58	58.0
Compound D, 	–12	58.0

7) The boiling points of HF, F_2 and HCl are given below.

Molecule	**Boiling point (°C)**
Hydrogen fluoride, HF	19.5
Fluorine, F_2	–188.1
Hydrogen chloride, HCl	– 85.1

Discuss the different boiling points of hydrogen fluoride, fluorine and hydrogen chloride in terms of the relative strengths of the intermolecular force between the particles involved.

8) Use the following information to answer the question below.

	ethanal	propanal	butanal	ethanoic acid
				
$\Delta_{vap}H$ / kJ mol^{-1}	26	30	34	52

Discuss the trend in $\square_{vap}H$ of the compounds in the table above in terms of the **attractive forces** between the particles and the **factors** affecting those forces.

9) Discuss the nature of the forces between molecules in each of the **three** substances given in the table below, **and** account for the variation in the melting points.

Substance	Formula	Molar mass (g mol^{-1})	Melting point (°C)
Propanoic acid	CH_3CH_2COOH	74	–20.8
Butanoic acid	$CH_3CH_2CH_2COOH$	88	–4.3
Ethyl ethanoate	$CH_3COOCH_2CH_3$	88	–83.6

10) A chemistry textbook was found to include a table showing the following information.

Substance	Bonds broken	$\square_{fus}H°$ kJ mol^{-1}	Melting point °C	Boiling point °C
Nitrogen, N_2	van der Waals	0.36	– 210	– 196
Heptane, C_7H_{16}	van der Waals	90.6	37	– 196
Water, H_2O	hydrogen bonds	6	0	100
Sodium chloride, NaCl	ionic	28	801	1467

(a) Describe what is meant by the term $\square_{fus}H°$.

(b) A knowledge of the nature of the substances in the table would indicate that the row of data for one of the substances is obviously incorrect.

Name this substance.

Discuss the nature of bonding in the substances named in the table above, and hence clearly explain why the row of data values can be identified as incorrect.